Sludge Characterization by Image Analysis

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In wastewater treatment plants by activated sludge, a complex ecosystem constituted mainly of bacteria, protozoa and metazoa is degrading the pollution. Bacteria are agglomerated as flocs, exopolymers helping to bind zoogleal bacteria to filamentous bacteria which constitute the backbone of the flocs. When a good equilibrium is not maintained between these two bacterial groups, problems occur such as pin-floc (when filamentous bacteria are not present), filamentous bulking (when too many filamentous bacteria are present) or viscous bulking (when exopolymers are produced in excess). The protozoa, which contribute to a decrease of the effluent turbidity (by consumption of free bacteria and suspended matter) and stimulate the bacterial growth (by grazing on the flocs) are very sensitive to the plant operation conditions. They can be classified as amoebae, flagellates and ciliated.

Generally speaking the species identification and the counting of filamentous bacteria and protozoa are performed manually, which is rather tedious and requires experts for the identification. Image-based procedures have been developed to try to solve this problem.

A fully automated procedure has been tested and validated at pilot scale and full-scale: a drop of sludge is examined with an optical microscope (no fixation or staining, brightfield examination), a series of monochrome images is grabbed and analysed to provide information on the number and total length of filamentous bacteria and the size and shape of flocs. More recently this analysis has been coupled to a Gram-staining procedure to evaluate the ratio of Gram-positive to Gram-negative bacteria, as an indication of the species distribution.

A semi-automated procedure has been developed in parallel for protozoa. The recognition rate is actually higher than 80% for some species. As the protozoa may be in contact with the flocs, the image segmentation is performed manually by the operator who defines a area of interest around the micro-organism. To improve the classification rate, new morphological descriptors are presently included.